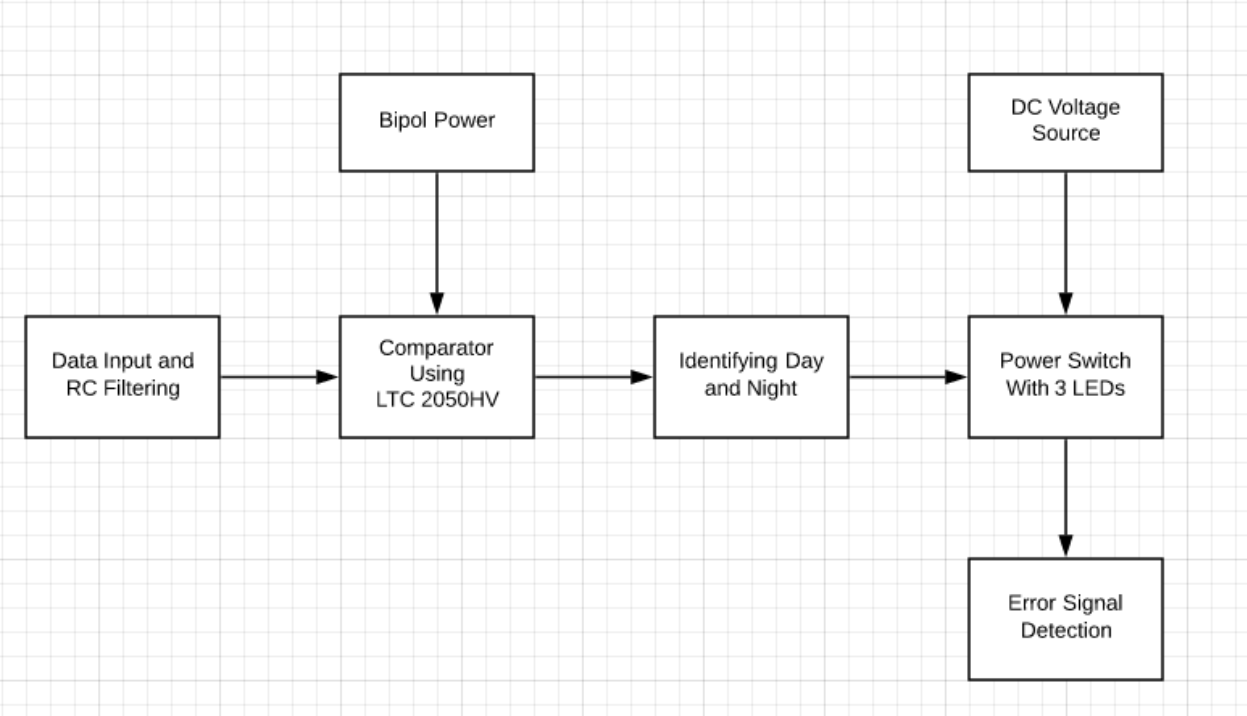
Problem Statement:

The street-lights in a street should be operated automatically by use of a light sensor. Because light intensity is changing by clouds or light from cars, thunderstorm lightning, a bird sitting on the sensor and so on, it is not possible to use simply a comparator to control the lights. Switching on and off very often is destructive for the lamps and would confuse people.

The electronics has to integrate over short events to find the right moment to switch on in the evening and off in the morning once a day.

Flow Chart of the Solution Overview:



To get the desired output the following procedures were followed:

1. **Data Input and RC Filtering**
2. **Comparator Output using LTC 2050HV**
3. **Power Switch With 3 LEDs**
4. **Error Signal Detection**

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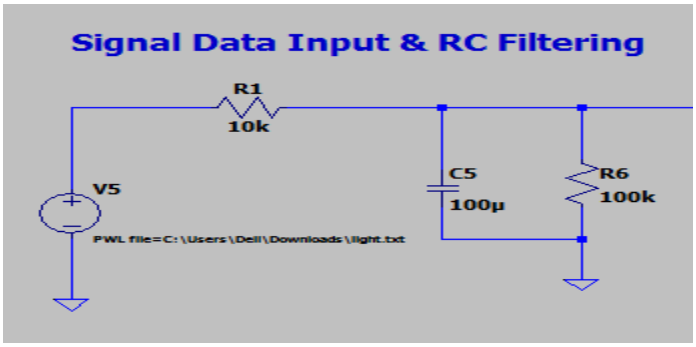
1. Data Input and RC Filtering

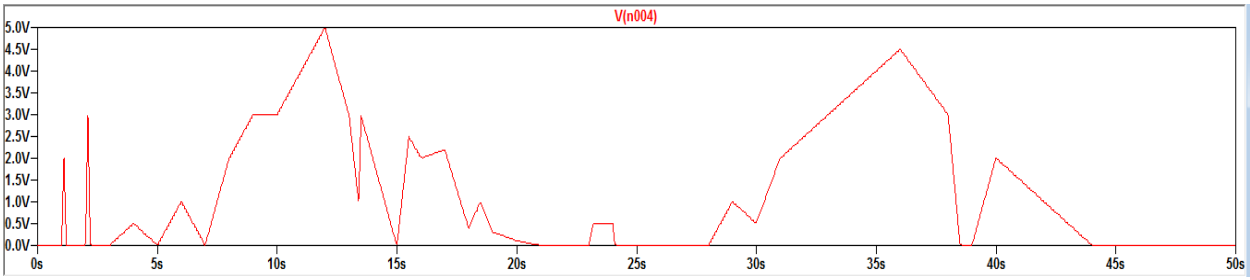
A Light.txt PWL File was uploaded onto a voltage source which acted as a light sensor for testing the signal source that represented daylight over some days and nights. The time was scaled down to every 1 sec for an hour to avoid too high simulation load.

Tested 2 days/nights equivalent to 48 secs.

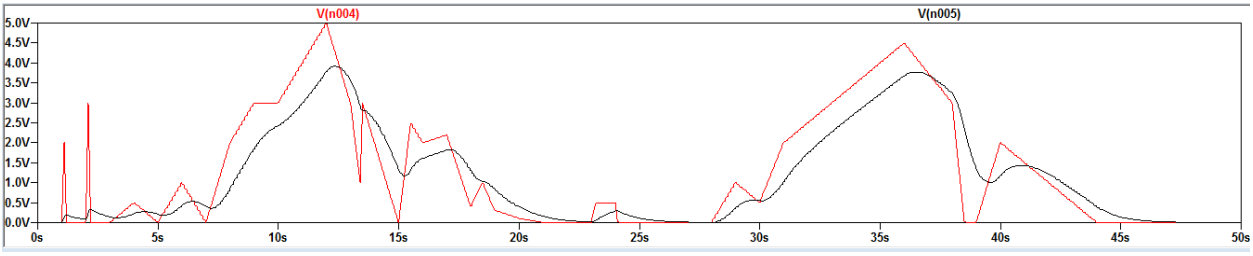
Circuit Diagram:



Output of the Light.txt uploaded onto the Voltage Source:



Output after RC Filtering:



Observation: R = 10K and C = 100u, so Time Constant = RC = 1. This Filter acts like a low pass filter.

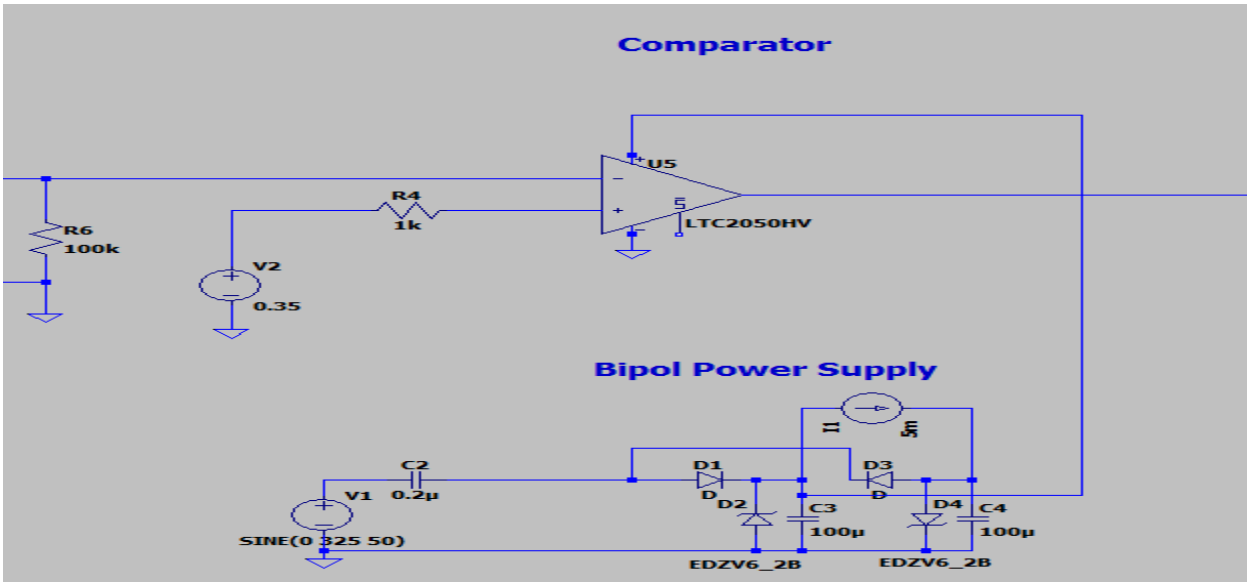
2. Comparator Output using LTC 2050 HV

A comparator was designed by giving the positive supply from the Bipol Power supply (6.2 V) and the negative supply was grounded.

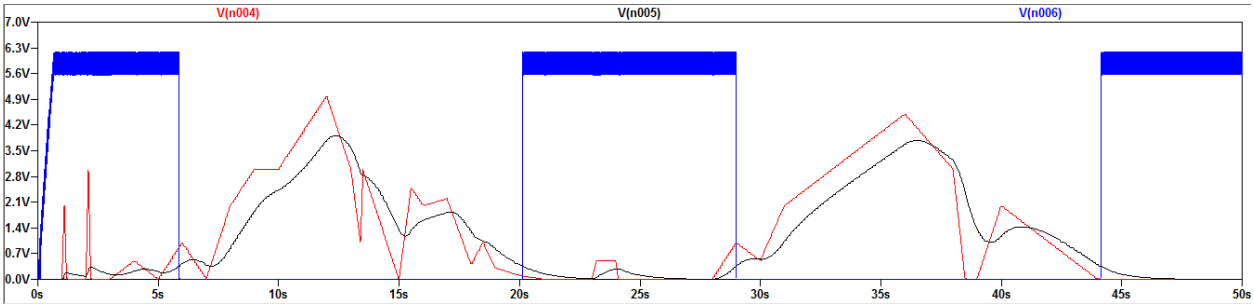
In the evening there should be a fast reaction by light on to avoid too much time with dark streets. A use of an Op-amp LTC 2050 HV was consider as it has low power consumption.

A reference voltage of 0.35V was calculated and obtained from the graph such that based on the comparison the LED's would be turned on or off.

Circuit Diagram:



Output:



Observation: The output obtained depicts the Day and Night. It represents when the LED's are on and when they are in the off state. The LED's remains on until 6 seconds. It switches on again at 20 seconds until 28 seconds and subsequently turns back on again at 44 seconds.

3. Power Switch With 3 LED's

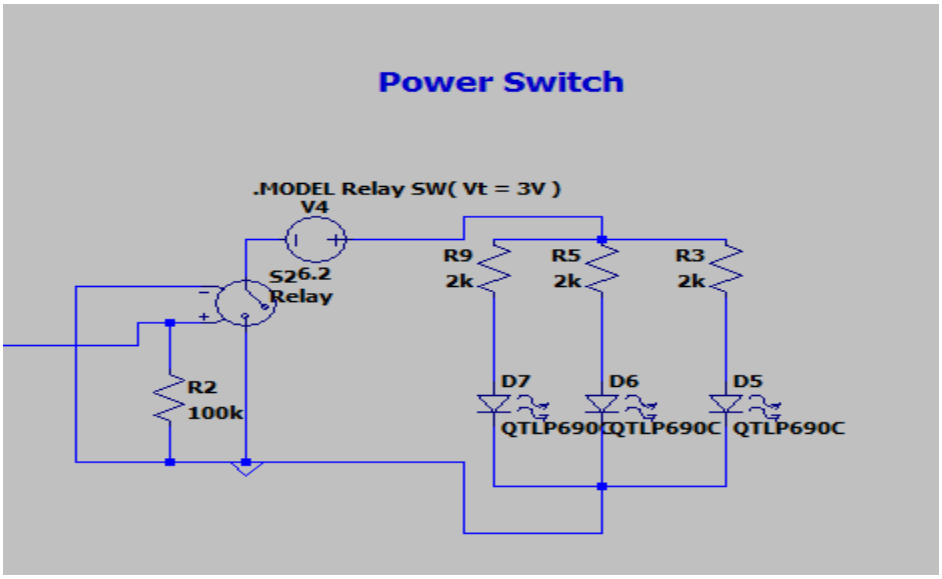
For switching on and off of the LEDs an electronic relay was used such it acts as a voltage controlled switch. It switches on above 3V at the input.

Initially a lamp was used but the current obtained across it was 0A, Hence LEDs with resistors are used as an alternative solution to it.

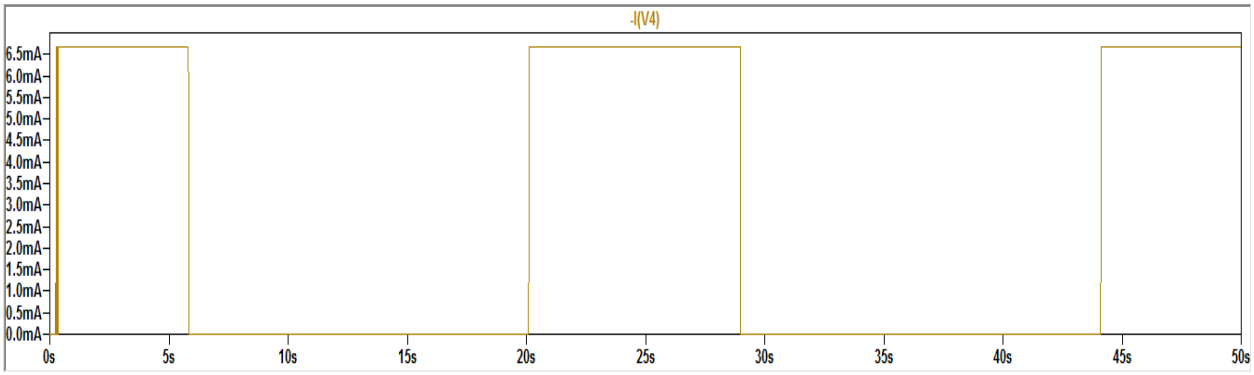
A DC Voltage were used as the simulation of AC voltage would exceed the performance in the simulation and an error would pop as time constant too small for simulation.

The comparator output is given to the positive of the switch and negative is grounded. The input impedance taken into consideration is 100K ohm

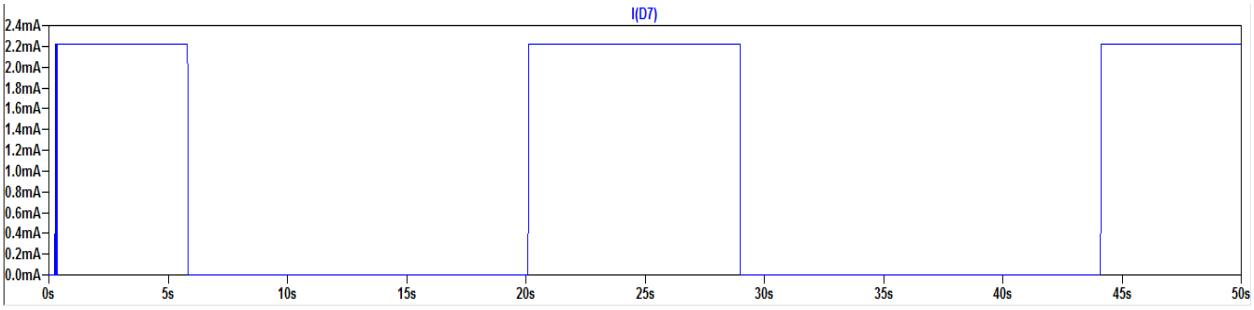
Circuit Diagram:



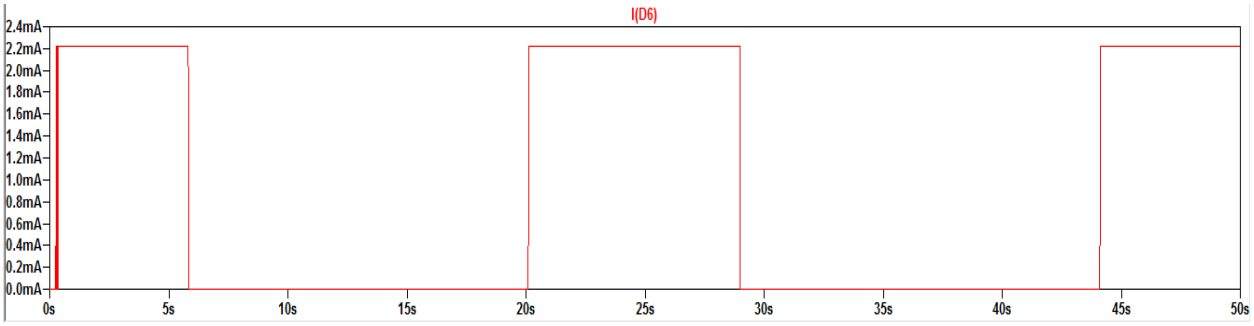
Output Current across the 3 LEDs: I=6.6mA



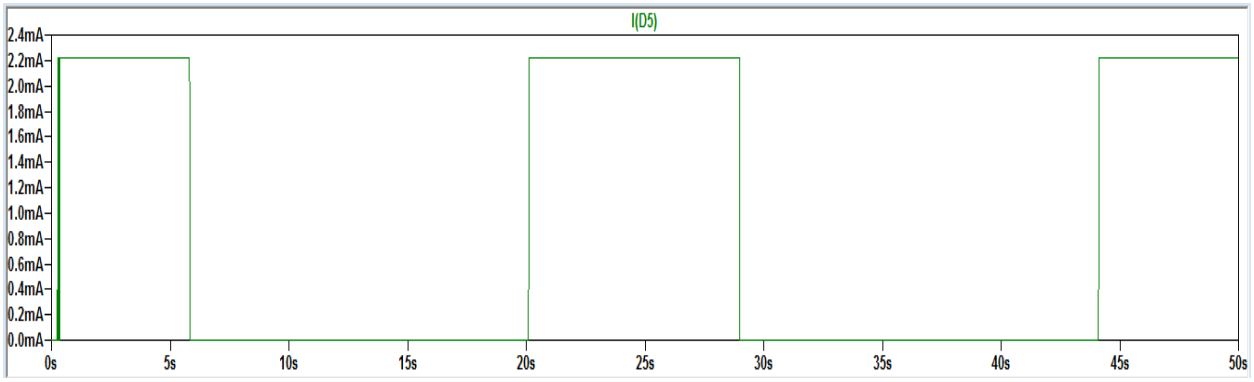
Output Current across each individual LEDs: I (D7) = 2.2mA



Output Current across each individual LEDs: I (D6) = 2.2mA



Output Current across each individual LEDs: I (D5) = 2.2mA



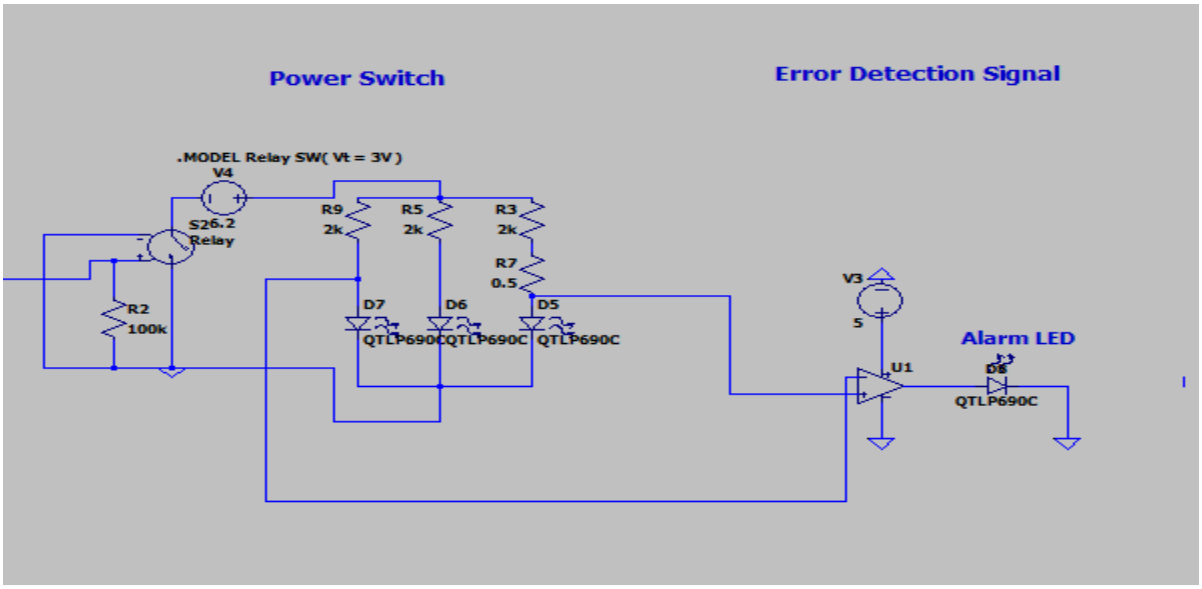
Observation: The on and off of the relay switch is based on the output obtained from the comparator and since the LED's are in parallel so the total current of 6.6 mA is equally divided into all the 3 LED's having equal resistance with an individual current of 2.2 mA.

4. Error Detection Signal

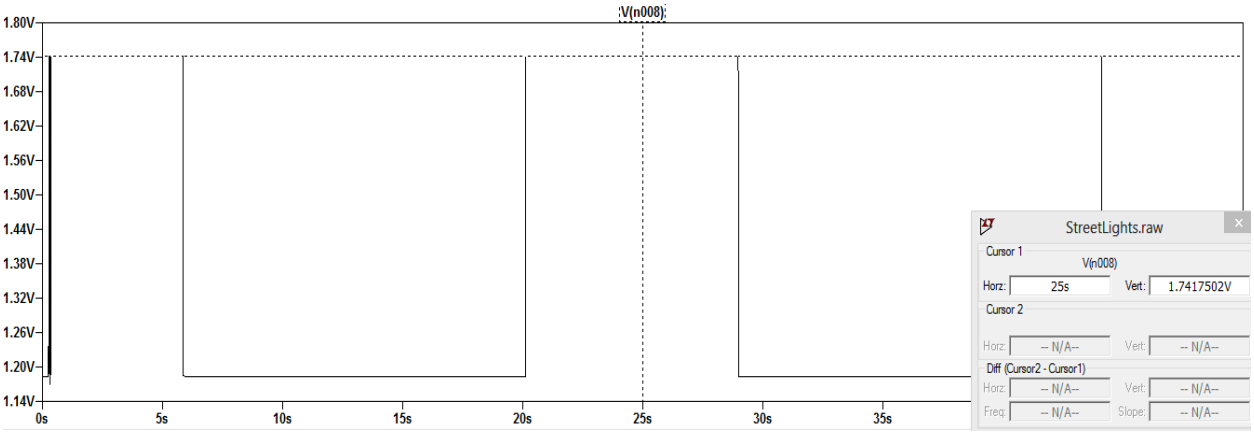
The electronics should generate an error signal, if a street-light is burned out, that means if the LED's total current has a smaller value than normal. To obtain the desired result a small resistor of 0.5 Ohm was used and the total current was measured such that it operates without too much power dissipation at the resistor.

A compactor is used to cover the voltage following across the 2 LED's where for one of the LED there is an addition of a resistor in order to reduce the voltage across the LED. In case the voltage is less than the required voltage, the alarm LED will turn off at the night but will be turned on during the day indicating that one of the LEDs is not functioning as expected.

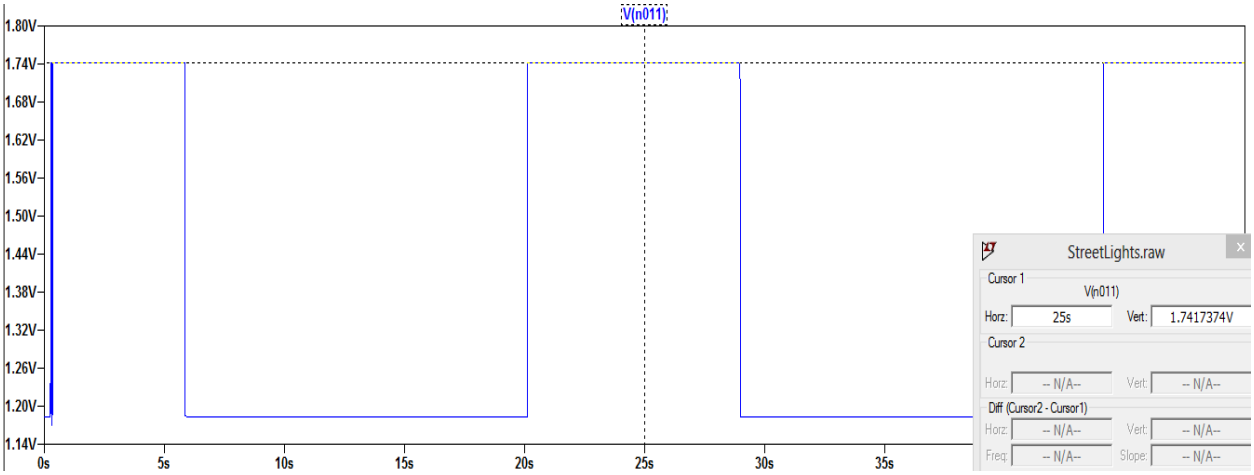
Circuit Diagram:



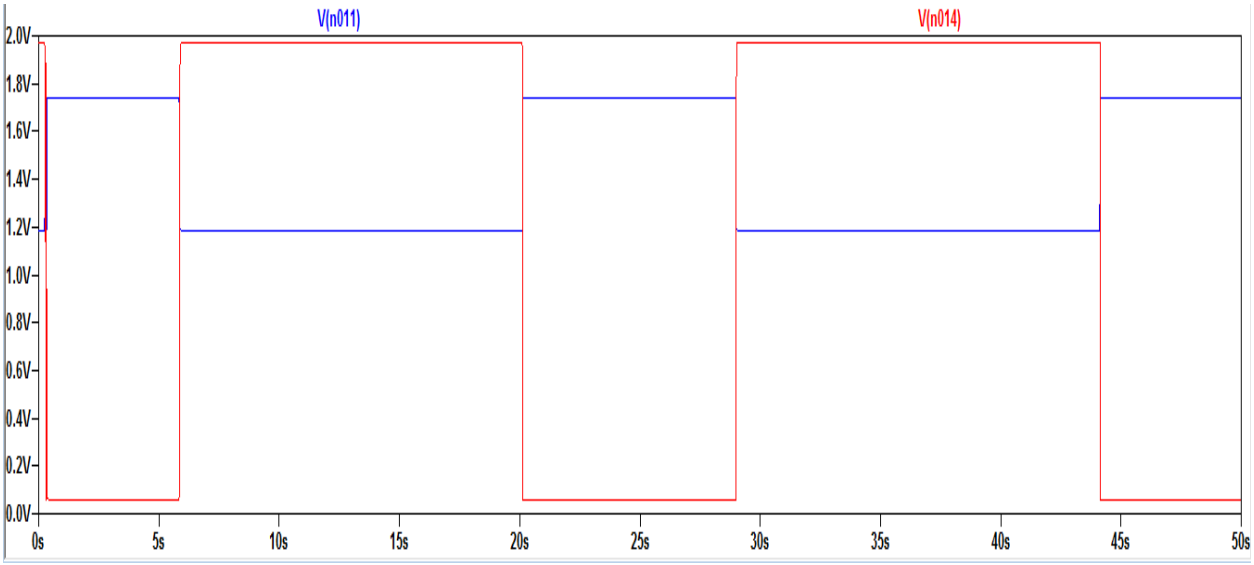
Output of a Reference Voltage: Vref = 1.7417520 V



Output with an Error Signal: Verror = 1.7417374 V



Output of the Alarm LED:

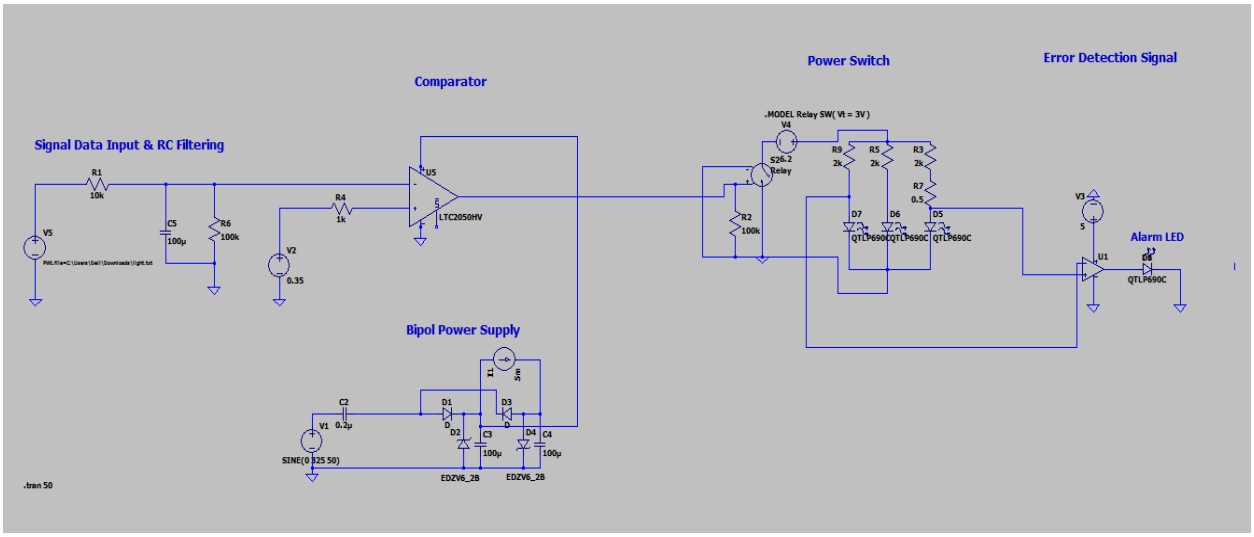


Observation: The Alarm LED will switch during the day time as indicated in the above graph where the voltage across it will be high indicating that there is a defect in one of the three LED's or no proper voltage is provided to the LED.

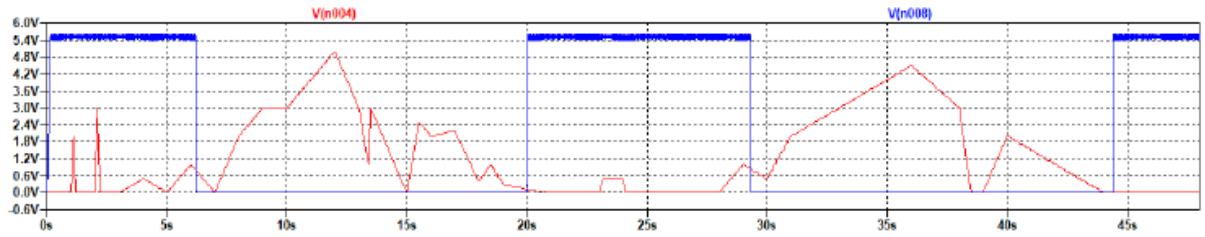
Final Circuit And Conclusion

The final circuit is a combination of all the 4 circuits in order to obtain the final output compared to the ideal graph provided as a reference in the project.

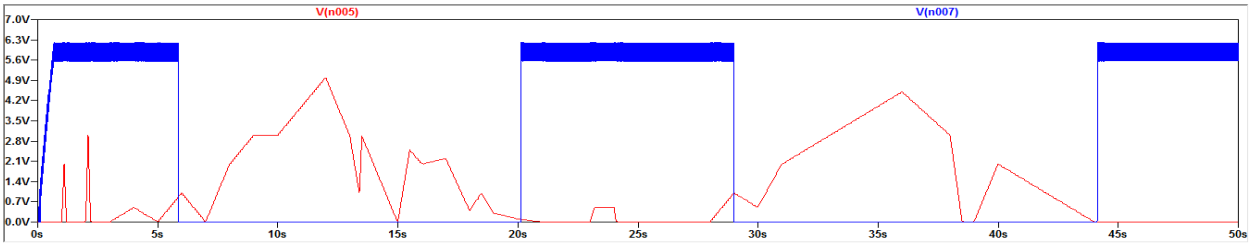
Circuit Diagram:



Expected Output:



Output Based on the Implementation:



Conclusion: The expected and the implemented output are the same were every 1sec is considered equal to an hour and the test is carried out for 2 days/nights which is equivalent to 48 seconds.